Title: Swimming Pool Construction

Brief Overview:

This learning unit deals with students developing a model that will confirm their understanding and use of volume. Students will state a hypothesis of how much water their model swimming pool will hold, and at the end, the students will test their hypothesis.

Links to NCTM 2000 Standards:

- **Mathematics as Problem Solving, Reasoning and Proof, Communication, Connections, and Representation**
  These five process standards are threads that integrate throughout the unit, although they may not be specifically addressed in the unit. They emphasize the need to help students develop the processes that are the major means for doing mathematics, thinking about mathematics, understanding mathematics, and communicating mathematics.

  Students will work together in groups to build a model pool given certain parameters. They will communicate through speaking and writing about their mathematical findings. In addition, students will make and investigate mathematical conjectures about their pool, and they will recognize that volume can be used in a variety of occupations.

- **Number and Operation**
  Students will use computational tools and strategies fluently and estimate appropriately.

- **Geometry and Spatial Sense**
  Students will use visualization and spatial reasoning to solve problems dealing with two- and three-dimensional geometric objects.

Links to Maryland High School Mathematics Core Learning Units:

Functions and Algebra

- **1.2.5**
  Students will apply formulas and use matrices (arrays of numbers) to solve real-world problems.

Geometry, Measurement, and Reasoning

- **2.1.1**
  Students will describe the characteristics of geometric figures and will construct or draw geometric figures using technology and tools.

- **2.1.2**
  Students will identify and verify properties of geometric figures using concepts from algebra and using the coordinate plane.

- **2.1.4**
  Students will validate properties of geometric figures using appropriate tools and technology.

- **2.2.1**
  Students will identify and verify congruent and similar figures and apply equality or proportionality of their corresponding parts.

- **2.2.2**
  Students will solve problems using two-dimensional figures and/or right triangle trigonometry.

- **2.3.2**
  Students will use techniques of measurement and will estimate, calculate, and compare perimeter, circumference, area, volume, and surface area of two- and three-dimensional figures and their parts. The result will be expressed with appropriate precision.

Data Analysis and Probability

- **3.2.1**
  Students will make informed decisions and predictions based upon the results of simulations and data from research.

Links to National Science Education Standards:

- **1.12.4**
  Students will formulate and support an explanation or model (physical, conceptual or mathematical) using appropriate instruments, including calculators, spreadsheets, databases, and graphing programs.

- **1.12.6**
  Students will interpret and communicate findings through speaking, writing, and drawing using developmentally appropriate methods including telecommunications technology.

- **1.12.10**
  Students will design, construct, and use models (e.g., math, computer, and physical) to make predictions about actual events.

Links to Maryland High School Science Core Learning Units:

- **1.2.2**
  Students will formulate and test a working hypothesis.

- **1.5.1**
  Students will demonstrate the ability to summarize data, investigative results, scientific concepts, and processes through drawing, written, and/or oral communication.

- **1.5.3**
  Students will create and interpret scale drawings.

- **1.6.1**
  Students will use ratio and proportion in appropriate situations to solve problems.

- **1.6.3**
  Students will manipulate quantities and/or numerical values in algebraic equations.

- **1.6.4**
  Students will judge the reasonableness of an answer.

Grade/Level:

Grades 9-10; Geometry

Duration/Length:

Three to four class periods (variable)

Prerequisite Knowledge:

Students should have working knowledge of the following skills:

- Measuring angles using a protractor
- Using area and volume formulas
- Solving proportions

Student Outcomes:

Students will:

- construct a model of a swimming pool based on certain criteria.
- make a prediction about the amount of water needed to fill the pool.

Materials/Resources/Printed Materials:

- Graph Paper 1 per group
- Rulers 1 per group
- Styrofoam Sheets 12 x 18 x ½ inch or whatever is available 2 per group
- Exacto Knife 1 per group
- Masking Tape 1 roll per group
- Waterproof Caulk 1 tube per group
- Graduated Cylinder 1 for class
- TI 82/83 Graphing Calculators (optional)

Development/Procedures:

Each group (3-4 students) will be head of a swimming pool construction company. The groups will put in a bid to build a swimming pool for an apartment complex. Each group will build a scale model of a swimming pool that will be from 15-25 centimeters wide to 20-40 centimeters long. Then each group will submit a diagram of the proposed swimming pool with labeled dimensions and predicted volume of the swimming pool. After the teacher has given the okay, the group will begin to build the swimming pool. Finally, each group will test the predictions. The group, which is most accurate to predicting the volume of its pool, wins the bid.

Assessment:

- The student has hired an exterminator to fumigate his garage. Given the dimensions of the garage and the price of the extermination, the student will explain if he/she is getting a good price or a raw deal. Students must show all calculations and justify answers.

- The Olympic Committee is planning to build an Olympic size swimming and diving Pool. The volume of the swimming pool in cubic yards determines the company's price. There is only enough money to build a swimming pool with a volume of 5,100 cubic yards. Given the length and depth, what must be the width of the pool?
  Show all calculations and explain which formulas were used, and how the answer was determined.

Extension/Follow Up:

- Have students create a different shape pool as a follow up project.
- Have students find the surface area of the pool.
- Have students construct a different pool with new dimensions.

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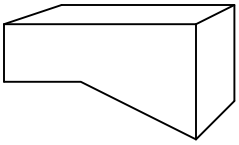
SWIMMING POOL CONSTRUCTION

You are the head of a pool construction company that is putting in a bid to build a pool for an apartment complex. You are responsible for building a scale model of a pool that will be from 15-25 centimeters wide and 20-40 centimeters long. The depth is your choice. The cross section of the pool must look like the following.



Before you are allowed to begin construction, you must submit a diagram of your proposed pool with labeled dimensions. You must also submit calculations for the volume of your pool. The accuracy of your prediction of the volume of the pool will be the basis for whether you are hired or not.

When your design is approved, you will then begin construction. Upon completion of the model, the prediction of the volume of the pool will be tested. The contractor, who builds the pool model with the closest actual volume to its predicted volume, will be considered the best and win the contract.

After the completion of each phase, you must submit the following:

Phase I: Planning of the Model

a) A completed diagram with dimensions of your pool
b) Detailed calculations of the predicted volume of water the pool will hold.

Phase II: Building Model and Testing Model

a) A finished model
b) Oral presentation of finished model

Phase III: Evaluation of Model

Report of results

Including answers to the following questions

1. Was your prediction accurate? Why or why not?
2. Would you change your construction if you did this a second time? Why or why not?
3. Would you alter your calculations? Why or why not?
4. If you were hiring, would you employ your own company? Why or why not?

PHASE I: PLANNING OF THE MODEL

Part A:

DIRECTIONS:
Sketch a diagram of the model of the pool using graph paper. Include dimensions for length, width, and depths in centimeters.

Part B:

DIRECTIONS: Calculate the volume of the model of the pool. Show and explain all work!! Remember that 1 cm^3 = 1 ml.

PHASE II: BUILDING AND TESTING MODEL

MATERIALS:

Ruler
Protractor
Styrofoam sheets
Exacto knife
Waterproof caulk
Masking tape
Measuring cup

DIRECTIONS:

1. Measure and mark with pencil the different pieces of Styrofoam you will need to build your model.
2. Cut Styrofoam using Exacto knife. Use extreme caution with knife.
3. Begin assembling model with caulk. Make sure angles are measured accurately. Use tape to hold together while drying.
4. Set model aside to dry for 24 hours.

TESTING PROCEDURES:

1. Present information on model orally. This is to be presented from a business standpoint. Remember to whom you are presenting. This report should include a description of your design, your predicted value of volume, and the reasons why your company should be selected to build the real pool.
2. Test your model. Pour predicted amount of water into model pool.
3. Identify accuracy of results. Determine accuracy by calculating ratio of predicted value vs. actual value.

PHASE III: EVALUATION OF MODEL

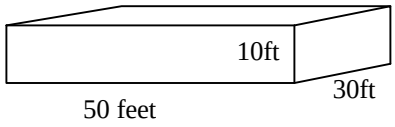
DIRECTIONS:

Write a paragraph of your result; you must include answers to the following questions.

Was your prediction accurate? Why or why not?
Would you change your construction if you did this a second time? Why or why not?
Would you alter your calculations? Why or why not?
If you were hiring, would you employ your own company? Why or why not?

ASSESSMENT QUESTION #1

An exterminator has been hired to fumigate your garage. The garage and dimensions are



The exterminator charges 3.5 ¢ per cubic foot of gas pumped into the garage.

The exterminator quotes a price of $500.

Explain if you are getting a good price or a raw deal. Detail and demonstrate how you arrived at your answer, include all calculations and justifications for your work.

TEACHERS GUIDE
ANSWER TO ASSESSMENT QUESTION #1

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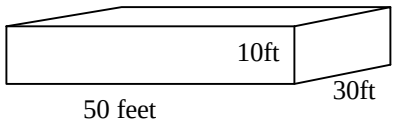

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ANSWER:

V=L*W*H	V*0.035 = price
V=50*30*10	15,000*0.035 = price
V=15,000 ft^3	$525 = price

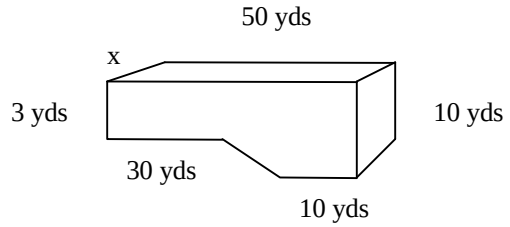
The volume of the garage was determined by calculating the volume of a rectangular prism. Once the volume was established, the price was multiplied by the cost per ft^3, thereby determining the price.

The exterminators quote is $500; the price is $525; therefore, the customer is not being cheated, and is actually saving $25.

Refer to rubric for grading

ASSESSMENT QUESTION #2

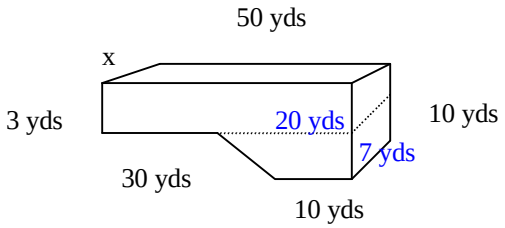
The Olympic Committee is planning to build an Olympic size swimming and diving pool. The volume of the swimming pool in cubic yards determines the company's price. There is only enough money to build a swimming pool with a volume of 5,100 yds^3. If the dimensions are as follows:



What must be the width of the pool?

Show all calculations and explain which formulas were used, and how the answer was determined.

TEACHER GUIDE
ANSWER TO ASSESSMENT QUESTION #2



$V= L*W*H_1 + ½ H_2 (b_1 + b_2) W$

$V=50*W*3 + ½ (7) (20 + 10) W$

$V=150W+105W$

$V=255W$

$5100=255W$

$W=20$ yds

To begin, the pool may be separated into two figures, a rectangular prism and a trapezoidal prism. The formula for the volume of a rectangular prism is L*W*H, the formula for the volume of a trapezoidal prism is $½ H (b_1 + b_2)W$.

Therefore, the formula for the volume of the entire pool is equal to the sum of the two formulas for volume.

The values are entered into the equation, and the width is determined by solving for W.

RUBRIC

#4 Response will include complete calculations, correct answer, very detailed explanation including formulas and calculations, how the answer was determined, and a rationale on the validity of the answer.

#3 Response will include complete calculations, correct answer, explanation including details of formulas and calculations, how the answer was determined, and a rationale on the validity of the answer. Explanation is correct, but may not be as detailed.

#2 Response will include, correct formula, incorrect answer, somewhat correct explanation.

#1 Response will include correct formula, incorrect answer, incorrect or no explanation.

OR

The incorrect formula, with correct answer according to the formula used, incorrect explanation.

#0 No response, irrelevant answer